To: Swain, Ed (MPCA)[edward.swain@state.mn.us]
From: Marko, Katharine
Sent: Thur 8/6/2015 10:38:05 PM
Subject: RE: sulfide, seagrass, and wild rice

Hi Ed,

Thanks for introducing yourself to me. I just recently started here in the Water Quality Branch of R5; I'm taking over a number of projects that were assigned to Chris Wagener. Yes indeed, I was affiliated with the Pacific Coastal Ecology Branch from 2005 until June of this year. While at PCEB I did work on a number of projects with Dave Young and a couple of other PIs there relating to seagrasses, both Zostera marina and the invasive Zostera japonica. I think the potential for comparisons between Zostera spp. and wild rice are very interesting and I will try and investigate this topic as well before our meeting next week, which is intended to get me up to speed on MPCA's actions regarding wild rice thus far. I am planning on attending the tribal consultation later this month in Duluth to observe in person.

In the meantime, let me know if you have any questions for me or any more information that you'd like to pass along.

Thanks,

Katie

Katharine Marko

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From: Swain, Ed (MPCA) [mailto:edward.swain@state.mn.us]
Sent: Thursday, August 06, 2015 4:53 PM
To: Marko, Katharine
Cc: Young, David
Subject: FW: sulfide, seagrass, and wild rice

Katie,

I think you and I will be on a conference call on August 13th regarding Minnesota's re-evaluation of the sulfate standard to protect wild rice—I've been one of the MPCA scientists on the project. As you will have gathered, we think that sulfate is not very toxic, but bacteria in the sediment convert sulfate into hydrogen sulfide in the sediment, which we think is the concern. But porewater sulfide is not just a function of sulfate (which is what we can regulate), but also other variables that control the net concentration of porewater sulfide; our statistical analysis identifies the most important variables as sediment iron and sediment TOC.

In my literature search for investigations that would illuminate this issue, I discovered that many marine biologists regard porewater sulfide as an important factor in the presence of many seagrass species. I recently found a useful 2009 USEPA report, *Seagrasses and Protective Criteria: A Review and Assessment of Research Status*:

http://www.epa.gov/wed/pages/publications/authored/Seagrasses%20and%20Protective%20Criteria%20EPA60
09050.pdf

Last week I called Walt Nelson, who edited the report, and Walt put me in touch with David Young (who says he knows you, see email below), who was co-author of chapter 6 (*Interactions of Zostera marina and Thalassia testundinum with Sediments*), which clearly lays out the same issues that we finally figured out for wild rice. Seagrass and wild rice do not have exactly the same life history strategies, but they both face the problem that elevated organic matter can allow bacteria to make toxic levels of hydrogen sulfide. The report's figure 6.1 (pasted in below) could be a diagram of the important factors that affect wild rice (except that it is seagrass!). Seagrasses tend to be clonal and can live multiple years, whereas wild rice is an obligate annual. But there is a lot that we in Minnesota can learn from the extensive seagrass scientific literature that addresses the potential toxicity of sulfide. Unfortunately, the small scientific community that had studied wild rice had not explicitly identified sulfide as an important factor. John Moyle, who had done his 1939 PhD thesis on the relationship between water chemistry and aquatic macrophytes occurring in Minnesota lakes (and was responsible for the generality that wild rice does best in lakes with less than 10 mg/L sulfate) did state in a 1975 deposition that he suspected that sulfide was the active agent (scan of his deposition is attached; he died in 1977).

David asked me to pass on his best regards. I hope to get the benefit of his expertise as we prepare our rule-making materials.

I'll talk to you next week!

Regards,

Ed

Edward Swain, Research Scientist, MPCA

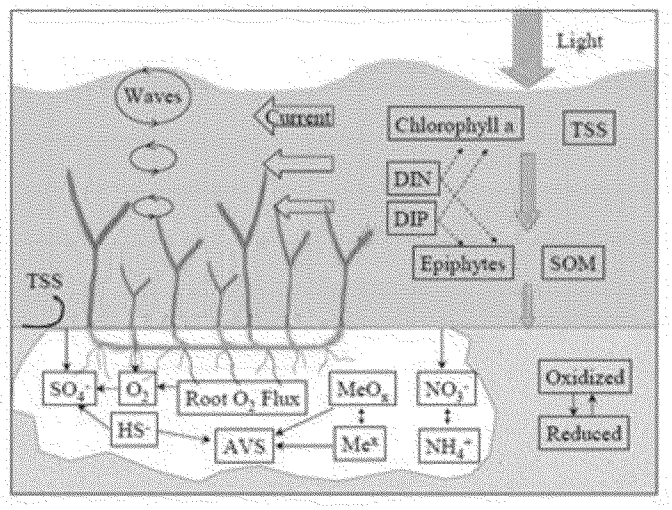

Figure 6.1. Both the water column and sediment environments influence seagrasses. While the physical and light attenuating water-column stressor may be the most important to the survival of the plant, the sediment geochemical processes, stimulated by sedimentation of reactive organic material from the water column, can affect seagrass health. Highly reduced sulfidic environments (HS^-) can reduce seagrass production and at times can become lethal to seagrass due to root death. HS^- and metals (Me^x) combine to produce non-toxic acid volatile sulfides (AVS). Thus the combination of high metal (Fe and Mn) in the sediments and diffusion of oxygen from the seagrass roots can reduce the toxic effects of sulfide in the near root environment (i.e., the rhizosphere) even under conditions of relatively high organic matter input to the sediments. (DIN – dissolved inorganic nitrogen, DIP – dissolved inorganic phosphorus, SOM – settling organic matter)

From: Young, David [mailto:Young.David@epa.gov]
Sent: Wednesday, August 05, 2015 11:49 AM
To: Swain, Ed (MPCA)
Subject: RE: sulfide, seagrass, and wild rice

Hi Ed,

I just came into the office for the day, called you first thing, then noticed that my cell doesn't seem to be giving me messages. So,

Yes, Katie and I have been colleagues and friends for years, and it is good to hear that she has already fixed on a problem of real scientific concern in her new work environment. When I was employed here at EPA, I worked for several years on the problem of intertidal sediment pore water dissolved sulfides, trying to see if our substantial summer accumulations of benthic green macroalgae (*Ulva* spp.) correlated with late summer developments of high DS at one site (Idaho Point). After three years I still couldn't prove it, as my "control" site (Coquille Flat) just across the channel had the same accumulations ob BGM one year (2000,) but no DS. The median level of DS at Idaho Flat in 2000 (~ 80 umole/liter) was an order of magnitude above the LC50 for aquatic mollusks and crustaceans (6±1 uM), and I think I have possible evidence that near-surface amphipods at Idaho were substantially depressed at that site. But there were confounding factors, and assumptions I had to make but didn't have time to test, so I never published this work (I still have hopes). I will try to attach an unpublished manuscript, and maybe a PP presentation I made this April on that subject. If you get in today, try reaching me at 541-867-4038, or leave a message and I'll call back again.

Please give my best regards to Katie.

David

From: Swain, Ed (MPCA) [mailto:edward.swain@state.mn.us]
Sent: Tuesday, August 04, 2015 9:26 AM
To: Young, David
Subject: sulfide, seagrass, and wild rice

Hi David,

Thanks for leaving me a voicemail the other day. I'm glad Walt relayed my interest in your expertise regarding seagrass. I'm trying to draw a parallel between Minnesota's wild rice situation and the information in the seagrass literature about the effect of sulfide (which in turn seems to be affected by organic loading and eutrophication). I just left a message on your cell phone voice mail asking you to try giving me a call again. Alternatively, you could suggest one or two times that it would be convenient for us to talk, and we could fix a time for a conversation. I'm pretty flexible on timing—a lot of people are not in the office this summer.

I'm also wondering if you ever ran into Katie Marko, who used to work as a biologist for the "Pacific Coast Ecology Branch" of the EPA. She is now at EPA Region 5, and she has been assigned to monitor Minnesota's efforts to protect wild rice from any negative effects of sulfate (and sulfide). Minnesota has a water quality standard of 10 mg/L sulfate to protect wild rice, which we are re-evaluating.

Hope to talk with you soon,

Ed

Desk: 651-757-2772

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